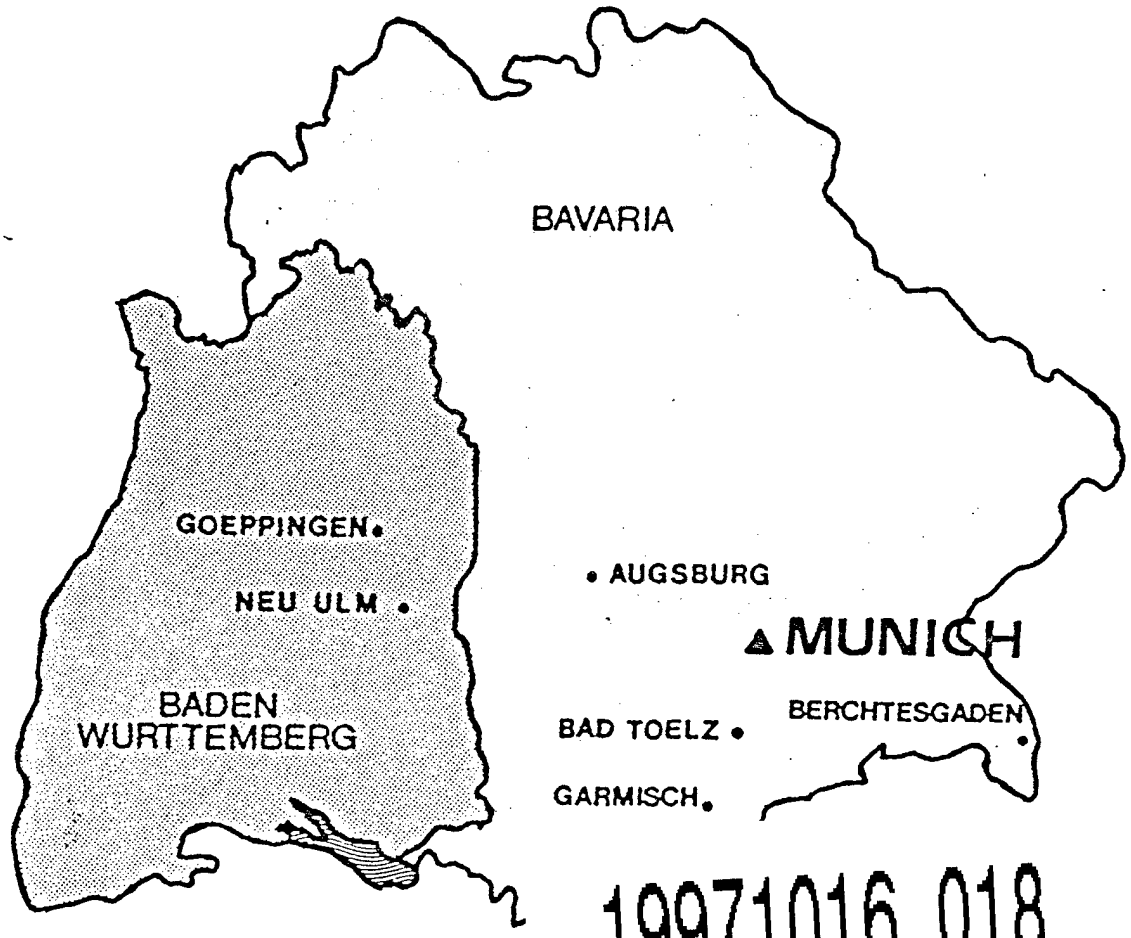
EEAP

PHASE III
EXECUTIVE SUMMARY



Munich Military Community
24 April 1986

VVKR | SUTER + SUTER

EXECUTIVE SUMMARY

I. PROJECT INTRODUCTION:

This document is the end result of the Energy Engineering Analysis Program (EEAP) at Munich Military Community in West Germany. This EEAP was authorized by the U.S. Department of the Army, European Division, Corps of Engineers, headquartered in Frankfurt, West Germany, under contract No. DACA-90-83-6-0023. The ultimate goal of this effort is the reduction of energy consumption in compliance with the objectives set forth in the U.S. Army Facilities Energy Plan.

The scope of services for this study defines the project in three phases of work. Phase I involves data collection for all buildings at Munich. The data collection phase includes utility data, determination and inspection of model buildings, assignment and review of similar buildings, and review of operating procedures. Phase II utilizes and relies heavily upon the information collected in Phase I. In this phase, energy conservation recommendations are developed to estimate related energy savings, as well as implementation costs for specific recommendations. Phase III of this project screened all energy conservation projects and provided programming documents for those projects which the community is requesting funding. By definition, any programmed project has a savings to investment ratio greater than one in compliance with the revised Energy Conservation Investment Program (ECIP) criteria dated June 1985. The three phases of work ended with no requests for funding. However, the first two phases of work compiled details of buildings and possible energy related modifications that can be used for future renovation activities.

II. PHASE I:

Phase I of the EEAP consists of "data gathering and inspection of the facilities in the field." During this phase, several GY areas were reviewed at this military community. Complete details of the data collection including energy use data, and all building survey data can be found in the Phase I Data Report.

A. Buildings Surveyed:

At Munich Military Community, the following GY areas were included under the contractual requirement for the EEAP:

GY 402 McGraw Kaserne: which consists primarily of administrative and community support facilities.

GY 199 Gruental Family Housing: which consists solely of family housing.

GY 228 Perlacher Forest Family Housing: which consists of family housing, school buildings, bachelor officer quarters, guest houses, a gymnasium, and various health care facilities.

GY 350 Chiemgaustrasse Billeting and Administration: which consists of bachelor officer quarters, civilian dormitories, troop housing, and administrative and maintenance facilities.

The other GY areas included in the Munich Master Planning area that were not a part of this Scope of Work are:

GY 046 Hepberg Ammo Storage
GY 133 Ingolstadt Autobahn Service Facility
GY 201 Harlaching Administration Facilities
GY 239 Warner Commissary
GY 764 Landshut LaFaire Vite Facility
GY 811 Columbia Hotel
GY 829 Eching Training Area
GY 991 Munich DYA Facility
GY 992 Saebenerstrasse Athletic Field
GY 993 Munich AFN Facilities

These areas were excluded from the Scope of Services by the EUD Project Manager due to the nature and type of buildings located in these GY areas, and also due to other recent energy studies under other contracts.

Four buildings surveyed at Munich Military Community were designated "Annex A Buildings." These facilities were audited in great detail in order to complete a computerized analysis of current energy use, possible energy conservation opportunities and the performance of the

existing heating and ventilating equipment. These Annex A Buildings surveyed at Munich were as follows:

GY 402 McGraw Kaserne
Bldg. No. 19 Motor Repair Shop/Stores
Bldg. No. 12 Quarters
Bldg. No. 3 Shops/Community Facility
Bldg. No. 4 Motor Shop

The other buildings surveyed at Munich in Phase I were designated as "walk through similar buildings." However, not all buildings on each GY area were surveyed as a part of this contract. The walk through similar buildings surveyed at the Munich Military Community were as follows:

GY 199 Gruental Family Housing
Bldg. No. 6001 Family Housing

GY 228 Perlacher Forest Family Housing
Bldg. No. 339 Family Housing
392 Grade School
397 Guest House/Gymnasium

GY 350 Chiemgaustrasse Billeting and Adminstration
Bldg. No. 104 quarters

GY 402 McGraw Kaserne
Bldg. No. 1 Office/School
2 Commissary/School
5 Garage
6 Office
7 Office/Garage/Mess
8 Quarters
10 Quarters
11 Quarters
13 Guesthouse
15 Store
16 Office/Canteen/Warehouse
17 Store/Warehouse
22 Office/Bank
42 Store
54 Office
60 Chlorination Buildings

As can be seen, all heated buildings at GY 402 were surveyed. At GY 228, GY 350, and GY 199, the contract required survey and review of only those buildings listed above. They were selected as representative of the other buildings in those GY areas by the EUD Project Manager and the Military Community.

Each of these walk through buildings were surveyed only to discern the differences between them and an Annex A Building that they we judged similar to. Due to he wide variety of building types at Munich, not all facilities could be made similar to one of the four Annex A Buildings at Munich. Since this EEAP contract encompasses six military communities, there was a total of 51 Annex A Buildings, 47 of which were located at other communities. These facilities were judged by EUD to be representative of all facilities on all military communities under contract. As a result, some buildings at Munich were judged similar to Annex A Buildings at another military community in order to provide computer simulation.

The list of these buildings at other military communities follows:

Community	GY	BLDG	BASIC USE(S)
Augsburg	187	704	Family Housing
Augsburg	536	9	Mess Hall
Augsburg	572	101	Command Building
Augsburg	863	63	Post Exchange
Augsburg	159	591	High School
Bad Toelz	283	1	Barracks
Bad Toelz	163	138	Family Housing Apartments
Bad Toelz	283	24	Family Housing
Berchtesgaden	818	302	Recreational Hotel

During the computer analysis of the energy consumption of each boiler plant, each Annex A Building was reviewed as if it existed at Munich, whether it did or not. That is, an Annex A Building from the Augsburg Military Community was analyzed with Munich weather data in order to make the similar building's analysis more accurate. Complete information on all of these buildings can be found in the Phase I Data Report.

At each building, whether reviewed as an Annex A Building or a walk-through similar building, an ECO checklist for the specific building under consideration was completed. This checklist noted over 110 Energy Conservation Opportunities (ECOs) that were reviewed at the facility. Each ECO was noted as "Completed" or "Not Completed" and if not completed, as "Feasible" or "Not Feasible." Based on this checklist, all energy conservation calculations were performed after incorporating the Phase I comments from both EUD and the military community. All ECO's noted as "Not Completed," and "Feasible" were reviewed for implementation. This checklist was also verified against the current ECIP Project List and the Master Planning Documents at Munich so that their would be no duplication of effort for projects already recommended and slated for implementation.

B. Energy Consumption History:

As reviewed in the Phase I Data Report, the Munich Military Community has steadily reduced its energy consumption since the peak year of FY 1975. By FY 1983, the total reduction has been 28%, thus surpassing the mandate established by the Department of the Army to reduce overall energy consumption by 20% from the FY 1975 levels. The energy consumption trends can be seen in the following chart

Energy Consumption History (MIL BTU)

FY	Electricity	Heating Fuel	Total Fuels
1975	206,410	676,904	883,314
1976	220,180	664,727	884,907
1977	211,700	594,663	806,363
1978	222,070	622,132	844,202
1979	203,673	453,674	657,347
1980	201,330	469,401	670,731
1981	202,408	439,051	641,459
1982	210,204	417,006	627,210
1983	218,764	414,412	633,176

For complete data and information on the Energy Consumption History, refer to the Phase I Data Report.

C. Energy Conservation Efforts since FY 1975:

The reduction in the energy consumption at Munich has been due to a number of factors. Perhaps the most significant has been the establishment of a Community - wide Energy Conservation Program by the Director of Engineering and Housing. This program has included an educational effort to inform every individual and each family on the Munich Community of the importance of energy conservation. This program ultimately affects every aspect of life at Munich. In addition, there has been an Energy Conservation Awards Program to recognize those individuals and groups leading the energy conservation efforts.

Since FY 1975, substantial energy conservation actions have been put into effect. These include the following measures.

GY 228 Perlacher Forest: Insulated school cafeteria roof, replaced balcony doors and windows on all family housing buildings with thermopane units. Installed heating controls in all buildings, installed attic insulation. Hot water usage controls installed.

GY 350 Chiemgaustrasse Billeting and Administration: Replaced single pane windows with thermopane buildings #101 - 111, 113, 114.

GY 402 McGraw Kaserne: Replaced single pane windows with thermopane windows, buildings #1, 2, 4, 6, 11 and 16. Repaired heating system, building #13.

III. PHASE II

Phase II of EEAP consisted of "analysis of data (collected in Phase I), performance of feasibility and economic studies and the identification of proposed projects." More specifically, Phase II consisted of 1) verification of computer simulated buildings' energy consumption versus actual utility bills; 2) identification of proposed projects and calculation of savings, costs, and SIRs; and 3) deletion of projects, as requested by Munich Military Community and required under ECIP criteria.

A. Methodology:

The basis of the analysis phase of this EEAP at Munich is the computerized analysis of the Annex A Building at this military community and at several other communities which were judged similar to other buildings at Munich. As noted earlier, the calculated energy consumption of each building at Munich was based on the computer analysis of these facilities.

The computer program utilized for this analysis is entitled C-PARTS (Component Performance Analysis for Real Thermal Systems). This program was developed and copyrighted by VVKR Incorporated of Alexandria, Virginia and is designed to allow an accurate assessment of each energy sensitive element in an existing building. The program utilizes standard American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) heat transfer methodologies and thermal resistance values for building materials from the National Bureau of Standards (NBS) or ASHRAE. Since the program was specifically designed with the analysis of existing buildings in mind, it is based on an hour by hour analysis of a typical day each month, and provides outputs that can easily be compared with the actual utility consumption data of an existing facility.

In this manner, the C-PARTS analysis can be checked against a known factor, the utility consumption of the facility for accuracy. Any significant deviations between the C-PARTS output and the actual consumption point to a problem in the C-PARTS data input or analysis. As a result, the final C-PARTS outputs have been verified against real data rather than a simple estimate of energy consumption.

As reviewed earlier, the vast majority of buildings analyzed are walk-through similar buildings. Each of these facilities was made similar to an Annex A building, located either at this community or another. For each walk-through building, a variation checklist was provided to note the differences between that building and the Annex A building to which it was judged similar. For example, two buildings may be similar in respect to the basic construction and use, but one has 25% greater window area and 30% greater floor area than the other. These approximate variations have been noted for each walk-through building in respect to its associated Annex A building. All heat transfer

coefficients, U-values, are assumed equal to those for the Annex A Building, unless noted otherwise.

After these analyses have been complete, each of the walk-through similar buildings at this community is analyzed by C-PARTS in relation to its associated Annex A building. The variations noted above are taken into account in the analysis process to derive an accurate estimation of the energy use at each individual walk-through facility.

B. Boiler Plant Verification Analyses:

The next procedure in the C-PARTS Analysis at this military community is the verification of the computed energy consumption against the actual energy consumption for the test year. There is no specific energy consumption data for each building. Rather, there is energy consumption data for central boiler plants and district heating consumption, which provide heat to a number of buildings, and for electrical substations, which provide power to a number of buildings.

After the energy consumption data has been calculated for all of the Annex A buildings and the walk-through similar buildings, the facilities are all grouped according to the central plants and substations or lowest metered source servicing them. The totals of these facility groupings are then verified against the historical energy consumption data.

There are several factors that can cause deviations between the ASHRAE computed loads of C-PARTS and actual consumption data. The major factors are as follows:

1. Lack of heating system controls that cause building occupants to open windows for comfort and thus increase infiltration losses,

2. Doors that are left open for excessive time periods especially in repair and maintenance facilities,

3. Non-scheduled or irregular use of a facility.

Whenever possible, corrections for these factors were introduced, based on additional data that was collected during the Phase I survey. This data includes the ambient air conditions on the day of the survey, the number of windows and doors found open, comments on leaking pipes, doors found open, poor heating system controls, building plans and blueprints and photographs of building conditions. With this additional information, and the ability of the C-PARTS program to rapidly re-evaluate the building loads, adjustments were made to account for the infiltration and other losses to verify the computer analysis with the actual energy consumption within reasonable limits.

C. Energy Conservation Opportunities:

The Energy Conservation Opportunities (ECOs) studies at this community was based on the Annex B requirements of the Scope of Services dated 20 January 1983. The ECO's noted in Annex B were those required by the Army for analysis. In addition to these, however, several additional ECO's were voluntarily added to the analysis procedure to provide a complete review of all feasible energy savings measures at this community. These additional ECO's also include some requested by various reviewing agencies after Phase I Data Report was submitted. Others requested were judged outside the requirements of this contract.

The ECO's proposed for review and analysis are divided into eight major groupings according to their building system. These groups are as follows:

		ABBREVIATION
1)	Building Envelope	(B)
2)	Cooling	(C)
3)	Heating	(H)
4)	Lighting	(L)
5)	Special Equipment	(S)
6)	Temperature Controls	(T)
7)	Ventilation	(V)
8)	Domestic Hot Water	(W)

Within these groupings, all ECO's under each Increment of study have been reviewed and analyzed. The analysis of each ECO was performed either by the C-PARTS program or by manual calculations, based on data derived from the C-PARTS analysis and Boiler Plant Verification Analysis.

Generally, the Building Envelope ECO's and Temperature Control ECO's were analyzed by re-running the C-PARTS load analysis for a specific building with revised inputs reflecting the ECO. For example, by analyzing the buiding first as existing, and then with additional roof insulation and comparing the two outputs, the energy savings associated with the roof insulation can be determined. These computer analyses were conducted on a full year's basis to obtain total savings in a year.

The manual calculations were based on data from the C-PARTS analysis of the facility or from the Boiler Plant Verification Analysis. All methods of the calculations were derived from ASHRAE or from several guidebooks provided by the U.S. Department of Energy.
The Master List of all Energy Conservation Opportunities that were reviewed at this community are as follows, though not all of these ECOs were applicable nor calculated.

BUILDING ENVELOPE

B-1 Insulation added to walls.

B-2.1 Insulation added to existing roof.

B-2.2 Insulation added with new roof.

B-3 Insulation added to basement ceiling.

B-4.1 Insulation added to attic floors.

B-4.2 Insulation added to usable attic.

B-5.5 Caulk and weatherstrip windows.

B-7.5 Caulk and weatherstrip doors.

B-8 Storm windows installed.

B-9 Storm doors installed.

B-10 Double pane windows installed.

B-11 Sun control screens or louvers added to windows.

B-12 Solar control film added to windows.

B-13.1 Glass area replaced with Spandrel panel

B-13.2 Glass area replaced with glass blocks

B-14 Automatic door closers installed.

B-15 Doors vestibuled.

B-16 Thermal barriers installed.

B-17.1 Double glaze skylights.

B-17.2 Remove existing skylights.

B-18 Loading dock doors sealed.

B-19 Air curtains installed.

B-20 Thermal/solar control shades installed.

COOLING SYSTEMS

C-1 Economizer systems provide free cooling during winter season.

C-2 Dual duct or multizone systems converted to single zone systems.

C-3 Cooling pipe lines and ductwork insulated.

C-4 Absorption cooling equipmment replaced.

C-5 Cooling equipment is serviced, cleaned and adjusted regularly.

C-6 Cooling of unoccupied areas is prevented.

C-7 Variable air volume systems installed.

C-8 Filters cleaned and inspected regularly.

C-9 Temperature of chilled water raised.

C-10 Solar assisted cooling equipment installed.

C-11 Reheat coils removed.

C-12 Heat recovered from refrigerant gas.

HEATING SYSTEMS

H-1 Combustion air to boiler preheated.

H-2 Fuel oil to boiler preheated.

H-3 Steam condensate returned to boilers.

H-4 Flue gas dampers installed.

H-5 Automatic ignition pilot lights installed.

H-6 Flue gas analysis and adjustment performed regularly.

H-7 Combustion is monitored and adjusted regularly.

H-8 Heating equipment converted from natural gas to oil or coal.

H-9 Steam, condensate and hot water piping insulated.

H-9.5 Insulate valves and fittings.

H-10 Unnecessary humidification removed.

H-11 Oxygen trim controls installed on boilers.

H-12 Heat recovery systems installed.

H-13 Solar energy heating system installed.

H-14 Reheat coils removed.

H-15 Temperature of hot water used for heating lowered.

H-16 Connected to district heating.

H-17 Turbulators installed in fire tube boilers.

H-18 Supply and return piping installed.

H-19 Spot heating installed.

H-20 Fluidized Bed Combustion System

H-21 Boiler Maintenance

LIGHTING SYSTEMS

L-1 Lighting fixtures removed.

L-2 Lamps and/or ballasts removed from fixtures.

L-3 Task lighting installed.

L-4 Lower wattage lamps installed.

L-5 Lamps and fixtures cleaned regularly.

L-6 Exterior lighting is reduced to minimum.

L-7 Lighting is off in unoccupied areas.

L-8 Photocell controls installed.

L-9 Automatic time clock controls installed.

L-10 Fixtures relamped on schedule.

L-11 Natural daylighting is utilized.

L-12 Incandescent fixtures replaced with fluorescent fixtures.

L-13 Exterior lighting replaced with low or high pressure sodium fixtures.

L-14 Mercury vapor fixtures replaced with high pressure sodium.

L-15 High efficiency ballasts installed.

L-16 Power reducers installed.

SPECIAL EQUIPMENT SYSTEMS

S-1 Time delay switches installed on elevator motors.

S-2 Motors and motor driven equipment are maintained and adjusted regularly.

S-3 Time clocks installed to turn off vending machines and drinking fountains overnight and during weekends.

S-4 Kitchen equipment and laundry equipment maintained and cleaned regularly.

S-5 Co-generation equipment installed.

S-6 Laundry waste air/water heat recovered.

S-7 Kitchen waste air/water heat recovered.

S-8 Individual metering of family housing installed.

S-9 Peak demand load controlled.

S-10 Electrical Load Replacement

TEMPERATURE CONTROL

T-1 Heating and cooling reduced to unoccupied areas.

T-2 Time clocks added to heating and cooling systems.

T-3 Tamperproof thermostats installed.

T-4 Thermostats set at 78° for cooling, 65° for heating.

T-5 Thermostats relocated from outside walls and from areas subject to drafts or direct sunlight.

T-6 Economizer controls added to heating and cooling system.

T-7 Temperature control system adjusted and recalibrated seasonally.

T-8 Automatic energy management systems installed.

T-9 Zone control implemented.

T-10 Thermostatic radiator control valves installed.

T-11 Night setback controls installed.

T-12 Outside air reset installed.

T-13 Duty cycling controls installed.

T-14 Heating monitoring devices installed.

VENTILATION SYSTEMS

V-1 Outside air reduced to minimum levels.

V-2 Exhaust systems balanced with the outside air intake systems.

V-3 Time clocks installed to shut down exhaust systems overnight and during weekends.

V-4 Outside air dampers sealed and adjusted to operate properly.

V-5 Exhaust hoods are equipped with make-up air systems.

V-6 Toilet exhaust fans wired to operate only when lights are turned on.

V-7 Heat recovery systems installed between exhaust air and outside air.

V-8 Maintenance Shop Exhaust system installed.

DOMESTIC HOT WATER SYSTEMS

W-1 Temperature of domestic hot water reduced.

W-2 Hot water piping insulated.

W-3 Storage tanks insulated.

W-4.1 Eliminate hot water use.

W-4.2 Time clocks installed to shut off water heaters overnight and during weekends.

W-5 Flow restrictors installed in faucets and shower heads.

W-6 Time clocks installed to shut off circulating water pumps overnight and during weekends.

W-7 System equipment is serviced, cleaned and adjusted regularly.

W-8 Solar hot water system installed.

W-9 Systems decentralized.

W-10 Hot water production supplemented by heat pump.

D. Projects Requested for Funding:

Of the complete list of ECOs reviewed, 66 were analyzed in detail, with calculations estimating energy savings and implementation costs. Of the 66 ECOs analyzed, no projects were requested for funding by the Milcom.

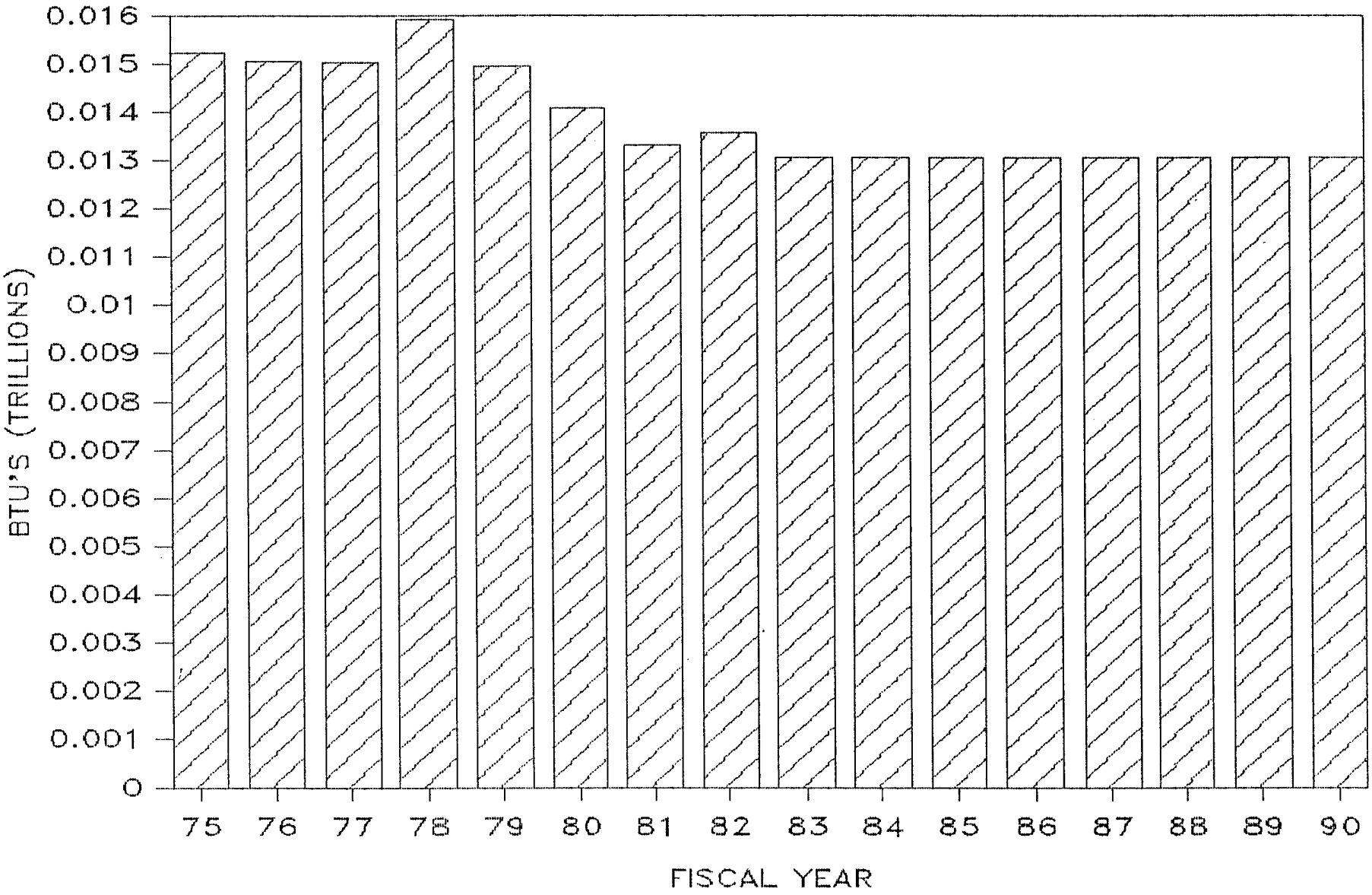
IV. PHASE III

Phase III of this study consists of preparing required programming documents, and preparing the Executive Summary. However, since Munich Milcom did not request funding for any of the ECO's analysed, only the Executive Summary has been prepared. The findings of the Phase II Energy Report can be used as guidelines for future energy conservation renovations. It contains much useful information for determining impact on basewide energy use for different energy related modifications to buildings.

The following graphs tract the energy consumption for the different energy sources being used at Munich Milcom. For years 1975-1983 actual consumption figures, provided by VII Corps were used. For years 1983-1990 straight line projections from the 1983 consumptions were used. The last graph depicts the cost of different energy sources. Actual costs were utilized for 1983. However, for years 1984-1990 the fuel costs were modified based upon the most recent trends and projections.

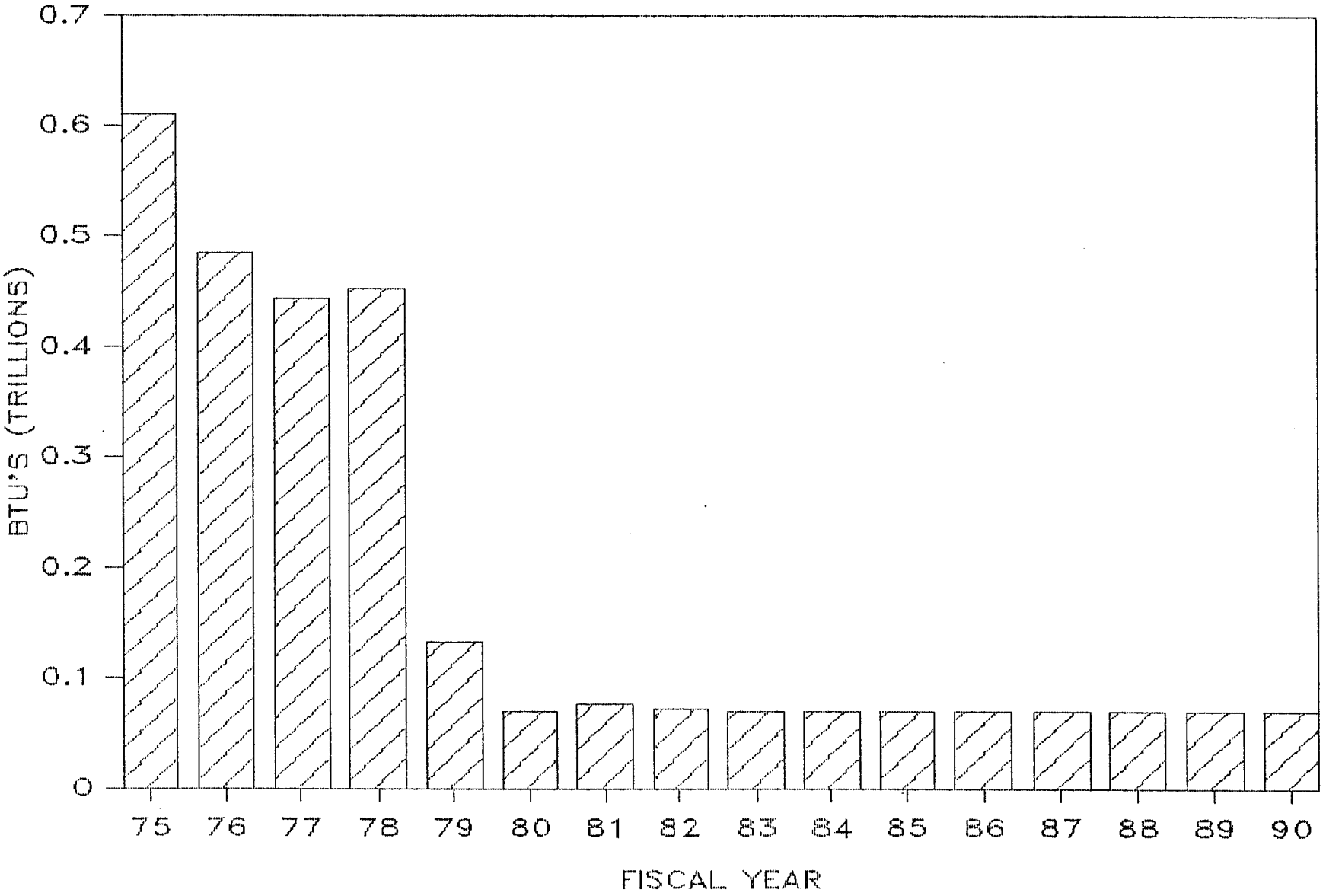
NATURAL GAS CONSUMPTION

MUNICH MILCOM



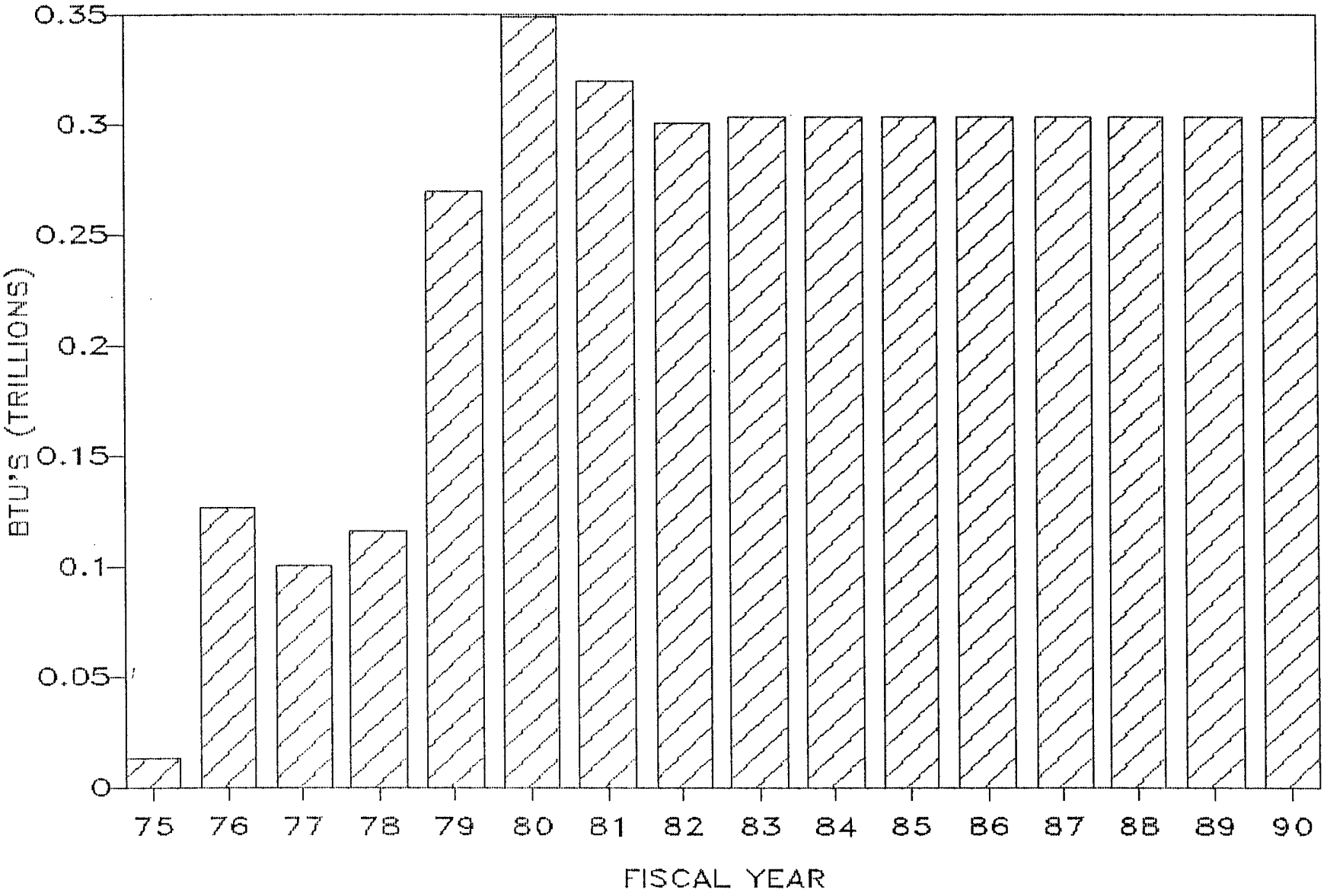
COAL CONSUMPTION

MUNICH MILCOM



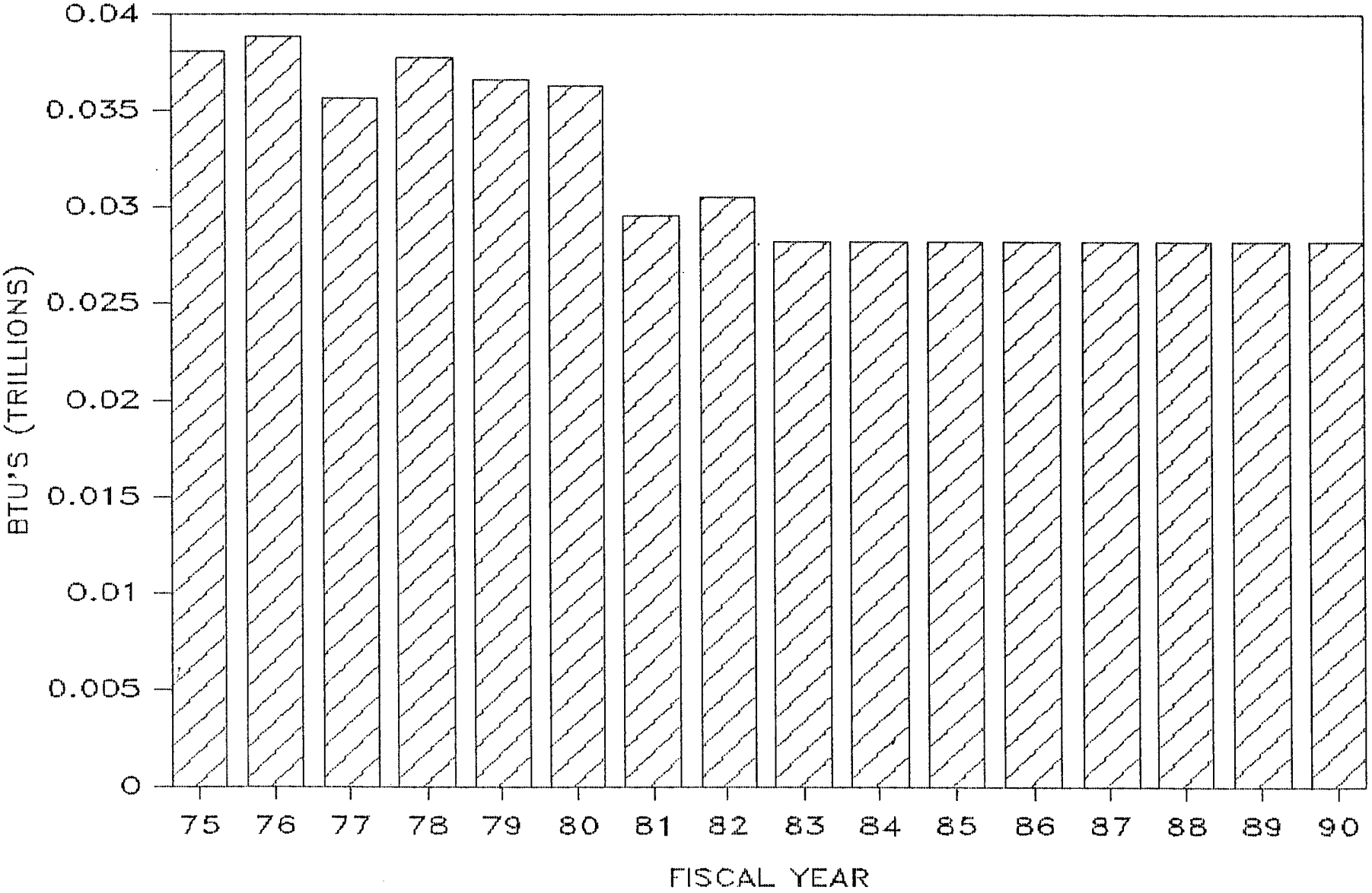
DISTRICT HEATING CONSUMPTION

MUNICH MILCOM



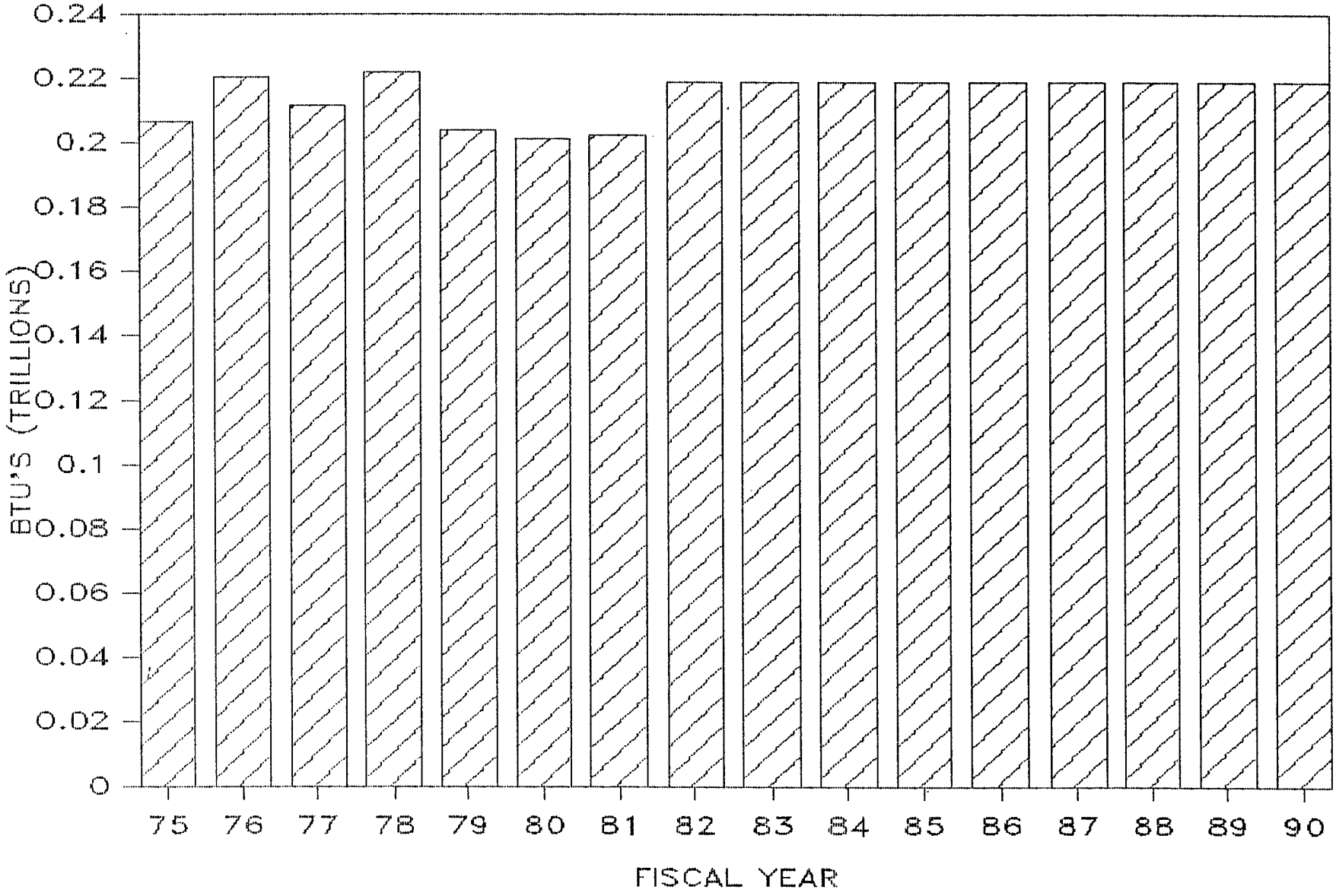
FUEL OIL CONSUMPTION

MUNICH MILCOM



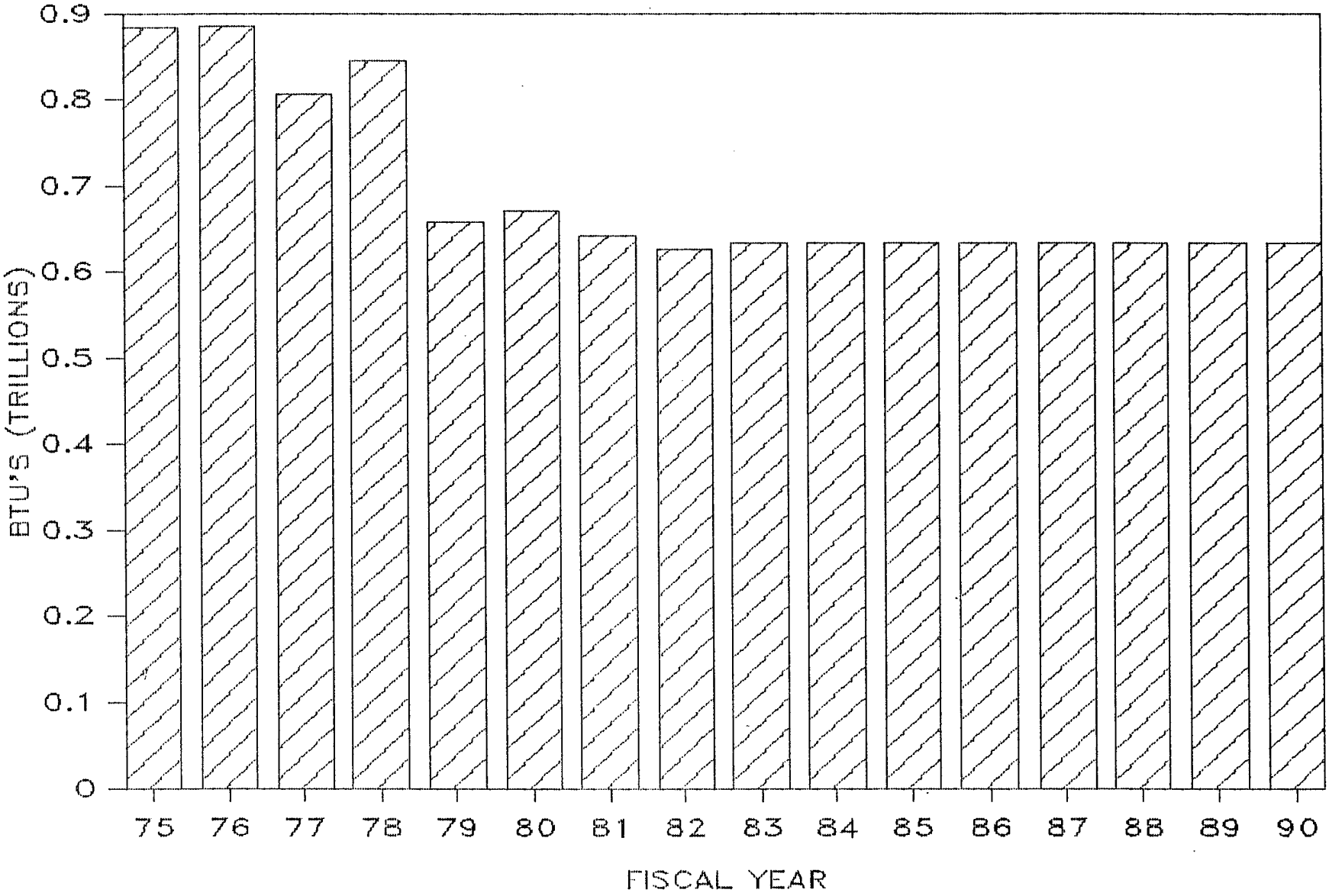
ELECTRICAL CONSUMPTION

MUNICH MILCOM



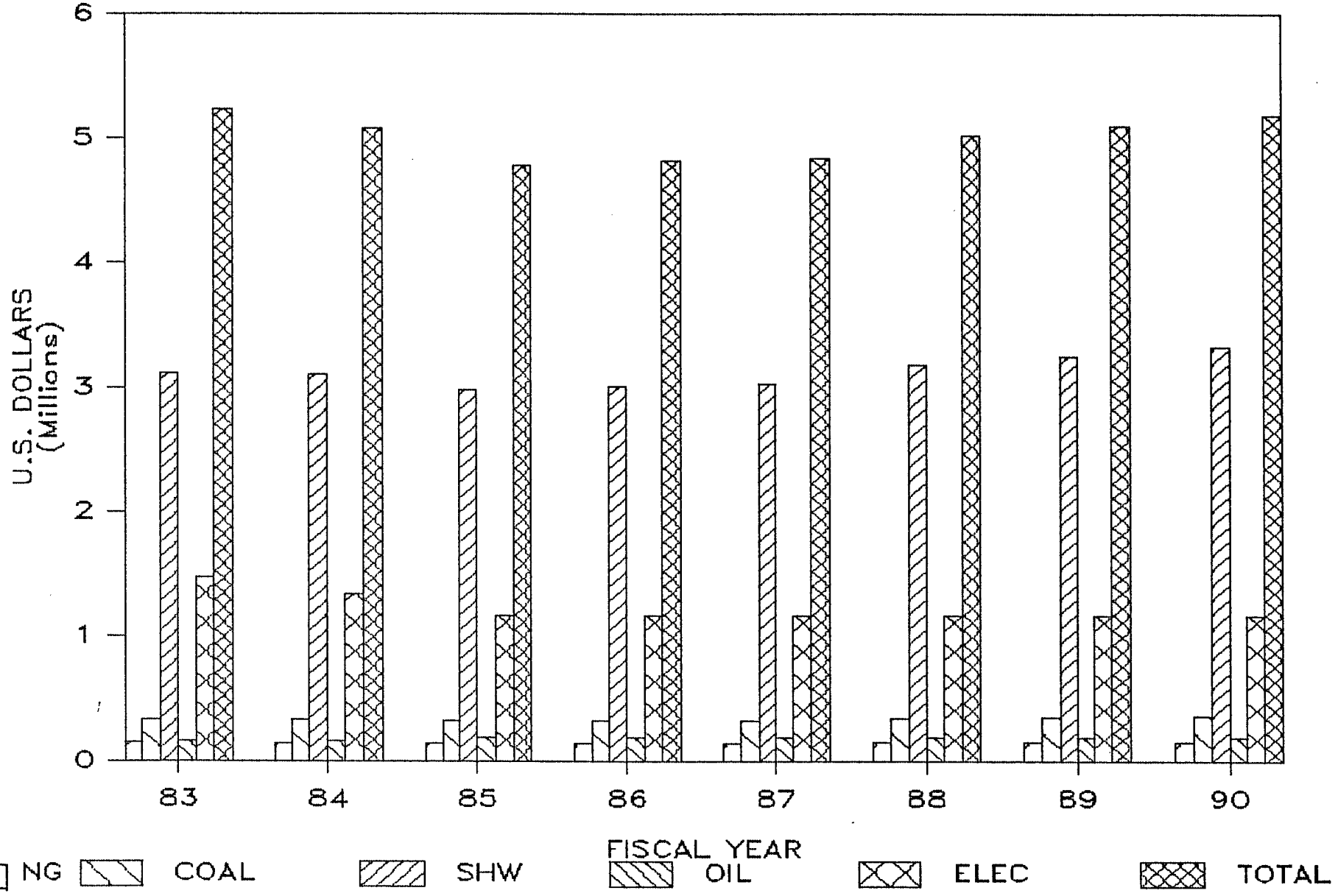
TOTAL ENERGY CONSUMPTION

MUNICH MILCOM



TOTAL PROJECTED ENERGY COSTS

MUNICH MILCOM



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